Bull. nat. Hist. Mus. Lond. (Geol.) **58**(supp): 45–50 Issued 26 June 2003

Gough's Cave 1 (Somerset, England): an Assessment of the Sex and Age at Death

ERIK TRINKAUS
Department of Anthropology, Campus Box 1114, Washington University, St. Louis, MO 63130, USA
LOUISE HUMPHREY & CHRIS STRINGER
Department of Palaeontology, Natural History Museum, Cromwell Road, London SW7 5BD, U.K.
STEVEN E. CHURCHILL
Department of Biological Anthropology and Anatomy, Box 3170, Duke University Medical Center, Durham NC 27710, USA
ROBERT G. TAGUE
Department of Geography and Anthropology, Louisiana State University, Baton Rouge, LA 70803, USA

SYNOPSIS. The overall impression of the sexually dimorphic characteristics of Gough's Cave 1 is that the remains are those of a male. However, the specimen does present some 'female' features in the facial skeleton, the ischiopubic rami and pelvic apertures, combined with relatively small overall size, and an ambiguous greater sciatic notch morphology. Nevertheless, the various features employed for sexual diagnosis of Gough's Cave are predominantly those which indicate or strongly suggest that it is male, but this must be accompanied with the caveat that either this individual falls at the feminine end of the male range of variation or that the patterns of skeletal sexual dimorphism of the population from which it derived were modestly different from those of the mostly European and European-derived reference samples used for this assessment. In contrast to the ambiguities of sex determination for Gough's Cave 1, the various indicators of his age-at-death are highly consistent. All of them agree in placing Gough's Cave 1 between his late second decade and middle third decade. He was unlikely to have been younger than about 18 years, and most likely was not older than about 23 years at death.

INTRODUCTION

The remains of Gough's Cave 1 have been considered to be those of a 'young adult male' since Seligman & Parsons' (1914) original partial description of the remains (e.g., Oakley, 1971; Stringer, 1985). The original assessment of the age in the second half of the third decade was based on their observations of cranial sutures, postcranial epiphyses and dental attrition. The sex assessment was based entirely on comparisons of femoral proximal and distal epiphyseal dimensions to those of Medieval British remains. However, since the remains contain many more indicators of both sex and age, these need to be reconsidered.

SEX DETERMINATION

Overall Body Size

Overall body size can provide a good indication of sex, if the individual in question falls above or below the area of overlap between the sexes. For this, the two best indicators are femoral length and femoral head diameter, since the former correlates closely with stature and the latter with body mass.

The femoral lengths of Gough's Cave 1 (439.0 and 433.0 mm – the difference due largely to differences in neck-shaft angle), fall slightly above an overall European Mesolithic male mean (430.8 ± 19.5 mm, N = 35) and on either side of the mean of a European Mesolithic male sample without the large Muge sample (435.9 ± 20.3 mm, N = 21) (for comparative samples, see Trinkaus, 2003). However, the average femoral length of Gough's Cave 1 is only 1.23 standard deviations from an overall Mesolithic female mean (407.8 ± 22.9 mm N = 21) and only 0.90 standard deviations from the mean of a female sample without the Muge remains (416.2 ± 21.9 mm, N = 10).

Similarly, the sagittal femoral head diameters of Gough's Cave 1 (47.7 & 46.3 mm) are close to Mesolithic male means (46.3 ± 2.2 mm, N = 32; 47.0 ± 2.6 mm, N = 17 without Muge). Yet, the z-scores of the mean diameter (47.0 mm) relative to the female samples are 1.59 for the full sample (42.7 ± 2.7 mm, N = 15) and only 1.06 for the female sample without Muge (43.7 ± 3.1, N = 8).

Consequently, these size considerations support a male sex determination for Gough's Cave 1, but they are not conclusive by themselves relative to other skeletally sexed European Mesolithic remains.

The Pelvis

The pelvic remains of Gough's Cave 1 present a mixture of male and female features, plus ones that are ambiguous. Yet, the overall impression is that of a male pelvis with some female proportions.

The greater sciatic notches (Trinkaus, 2003: fig. 2) appear to be intermediate between the classic male semi-circular form and the more open female pattern. In addition, the right ilium, but not the left one, has a clear pre-auricular sulcus.

The ischiopubic rami (Trinkaus, 2003: fig. 3) are relatively thin and flare ventrally along their medial margins, a generally female feature (see Poulhés, 1947; Phenice, 1969). Yet, the small mediolateral breadth of the symphyseal body (obturator foramen margin to symphyseal surface), the thickness of the superior pubic ramus, the absence of a subpubic concavity, and the vertically elongated shape

Table 1 Results of pelvic discriminant function analysis for Gough's Cave 1.

Reference Sample	Female N	Male N	% Correctly Classified	Gough's Cave 1 Sex Assignment
Euroamericans				
pelvic variables	40	35	98.7%	male
pelvic and femoral variables	39	34	100%	male
Afroamericans				
pelvic variables	42	40	97.6%	male
pelvic and femoral variables	41	39	100%	female
Pooled Sample				
pelvic variables	113	123	95.8%	male
pelvic and femoral variables	107	116	98.7%	male

of the obturator foramen all indicate a male. This is supported by its subpubic angle (64°), which is very close to a recent Euroamerican male mean (63.7° ± 7.8°, N = 50) and well below that of a Euroamerican female sample (88.4° ± 8.5°, N = 50) (Tague, 1989) (other recent human samples exhibit similar mean angles and distributions for males and females (Tague, 1989)).

At the same time, the shape of the pelvic inlet is exceptionally round (Trinkaus, 2003: fig. 4), since its dorso-ventral and transverse diameters are equal, providing an index of ca.100. In contrast, a sample of Euroamerican male pelves has a mean index of 79.0 (± 7.9, N = 47) and a female sample has a mean of 83.1 (± 10.0, N = 47) (Tague, 1989). Its outlet index of 104.2 falls between the means of those male and female samples (111.1 ± 14.1, N = 44 and 99.8 ± 11.0, N = 46, respectively).

Given the mixed indications of these individual sex characteristics of the Gough's Cave 1 pelvis, we performed a discriminant function analysis of a series of measurements of the pelvis and femur in order to resolve the sex assessment of Gough's Cave 1. The measurements were selected for overall proportional coverage, preservation and body size indication. Those employed are: sacral ventral height and arc, sacral antero-cranial breadth, pelvic antero-posterior inlet, midplane and outlet diameters, bi-iliac breadth, pelvic inlet transverse breadth, minimum bi-acetabular breadth, bi-tuberous (outlet) breadth, sub-pubic angle, and maximum length and head diameter of the femur. The analyses were performed with just the pelvic dimensions and combining the pelvic and femoral dimensions.

These measurements were compared to three samples. The first was of Euroamericans with documented sex, given the geographical origins of Gough's Cave 1. The second is of Afroamericans of documented sex, given the slightly linear body build of Gough's Cave 1 (Holliday & Churchill, 2003). The last includes the first two samples, plus four samples of Amerindians with skeletally determined sex (see Tague (1989) for sample composition). The analyses were done first using only the modern human reference sample, and Gough's Cave 1 was then included to determine its affinities.

As can be seen in Table 1, Gough's Cave 1 is assigned to the male sample in all but one case, when the reference sample consists of Afroamericans and the femoral variables are included in the analysis. This single exception is almost certainly a result of the slightly linear proportions of the Gough's Cave specimen combined with the relatively tall stature of the individuals in that reference sample.

The Skull

The overall impression from the Gough's Cave 1 cranium is that of a male. Although we do not have other crania from the same population for comparison, the prominence and volume of the mastoid processes suggest that the cranium is that of a male. A further indication that the cranium is male is the presence of a pronounced crest on each suprameatal triangle, which extends the zygomatic process almost as far as the parietal notch. The cranium has marked temporal lines with both the upper and lower temporal lines extending to the lambdoid suture.

The appearance of the occipital is also that of a robust individual. It has marked superior and inferior nuchal lines and a well-defined external occipital crest. The area of the external occipital protuberance is partially obscured by sediment, but it is clearly not a prominent feature.

The sexually diagnostic features of the upper facial region and frontal bone are ambiguous. The right side of the glabella and right supraorbital margin are partially obscured by a pathological lesion. Based on what can be seen, the glabella is only moderately prominent and the supraorbital ridges are not particularly well-defined. The supraorbital margin is of moderate thickness and sharpness.

Relative to the overall impression from the cranium the mandible appears to be that of a more gracile individual (for a detailed description of mandibular morphology, see Humphrey & Stringer, 2002). The mental protuberance and mental tubercles are not particularly prominent. The gonial region is everted and the areas of attachment of the masseter and medial pterygoid are well defined.

Buikstra and Ubelaker (1994) emphasised five aspects of cranial morphology that can be useful for sex determination. Each feature is scored on a five-point scale, with higher values representing more robust masculine features. A score of 1 indicating a probable female, a score of 5 indicating a probable male and a score of 3 indicating that the feature is ambiguous. The scores for the Gough's cave cranium for each of the five sexually diagnostic structures are:

Robusticity of nuchal crest: 5; size of the mastoid process: 5; sharpness of the supraorbital margin: 2; prominence of the glabella: 3; and projection of the mental eminence: 2–3.

The skull therefore presents a mixture of robust and gracile characteristics. The most masculine features relate to the attachment of the nuchal and temporal musculature, while the supraorbital region and mandible present features that are not obviously masculine or feminine.

The Gough's Cave 1 cranium was compared metrically to a sample of European Mesolithic and Late Upper Palaeolithic crania (Humphrey and Stringer, 2002). The crania were measured according to the system devised by Howells (1973). A total of 39 cranial measurements were made of Gough's Cave and the comparative sample included only crania on which the same set of measurements could be taken. Principal components analysis of 39 cranial dimensions suggests that Gough's Cave 1 is male (Humphrey & Stringer, 2002). A stepwise discriminant analysis using the same comparative sample classifies Gough's Cave 1 as male (Humphrey & Stringer, 2002).

Summary Sex Assessment

The overall impression of the sexually dimorphic characteristics of Gough's Cave 1 is that the remains are those of a male. This is supported by posterior and posterolateral cranial features, long bone lengths, many discrete pelvic traits and particularly discriminant functional analysis of the pelvis. However, the specimen also presents a series of features that are generally considered to be female characteristics, including several features of the facial skeleton, the ischiopubic rami and the pelvic apertures. This is combined with its overall size being well within Mesolithic female ranges of variation, and its ambiguous greater sciatic notch morphology.

We feel that the various features employed for sexual diagnosis of Gough's Cave are predominantly those which indicate or strongly suggest that it is male, but this must be accompanied with the caveat that either this individual falls at the feminine end of the male range of variation or that the patterns of skeletal sexual dimorphism of the population from which it derived were modestly different from those of the mostly European and European-derived reference samples used for this assessment.

AGE ASSESSMENT

In their presentation of the Gough's Cave 1 remains, Seligman & Parsons (1914) make several references to its age at death, including 'the sutures are open both extra- and intra-cranially, a condition which would make us fairly sure that that the individual was under 30 years of age' (p. 255), 'the teeth in the lower jaw are very perfect and, although their possessor was probably between 24 and 28 years of age, show very little sign of grinding down' (p. 258), and 'a part of the left os innominatum has been preserved and shows that the epiphyseal line for the crest of the ilium is not completely closed' (p. 261). 'As all other available epiphyseal lines have disappeared in this skeleton we should say that death took place between the ages of 24 and 28, and this is quite in harmony with the evidence of the skull' (p. 261). Given the presence of a variety of other age indicators on the remains (of varying precision), a reassessment of these statements is in order.

The Skull

Parts of the basicranial region are missing so it is not possible to examine the area of the basi-occipital synchondrosis. However, most of the cranial vault sutures remain, permitting their assessment endocranially and ectocranially.

The reliability of cranial suture closure for age estimation is debated. Nevertheless, several different systems have been developed for estimating age at death from suture closure on the endocranial and ectocranial surfaces of the skull (e.g. Meindl & Lovejoy 1985, Perizonius 1984, Buikstra & Ubelaker 1994). Key *et al.* (1994) conducted a detailed investigation of cranial suture closure in 183 individuals of known age at death from the Christ Church, Spitalfields sample. Their study recorded the degree of closure at 54 different sites on the cranial vault. Key *et al.* (1994) demonstrated a high level of variability in suture closure with age in the Spitalfields sample. In particular, their study warned that open ectocranial sutures were found to occur with equal frequency at all ages, and should not be used as an indication of young age.

The degree of suture closure in Gough's Cave 1 was evaluated using the methods described by Key *et al.* (1994). Observations could be made at 24/36 ectocranial sites and at 14/18 endocranial sites. All except two of the recording positions could be scored on either the left or right side of the skull. Suture closure was scored as 0 at each of the sites examined. The conclusions of Key *et al.* (1994) suggest that this result does not provide any definitive evidence of age at death, and perhaps all that can be concluded in relation to the evidence from cranial suture closure in Gough's Cave 1 is that it does not conflict with other morphological indicators of a young age at death.

Table 2 Degrees of occlusal attrition in Gough's Cave 1, scored following the system of Molnar (1971).

		Right	Left
Maxilla	M^1	2	3
	M^2	2	2
	M^3	1	1
Mandible	I_1	3	3
	I_2	3	3
	C_1	3	3
	P_3	–	3
	P_4	–	2
	M_1	3	3
	M_2	2	2
	M_3	1	1

The Dentition

All of the teeth present in the upper and lower jaws are fully emerged into the tooth row, suggesting a minimum age at death of about 17 years (Smith 1991, table 1). Radiographs reveal that the roots of the mandibular third molars are complete and appear to be completely closed at the apex. The mean age of attainment of apical closure of the third molar in a recent North American sample is 20 years for males and 20.7 years for females (data from Moorrees et al. 1963, presented by Smith 1991). The minimum age of attainment of this stage is just over 16 years (mean – 2sd, for age of closure of distal root apex (Moorrees *et al.*, 1963).

It is also possible to assess the degree of wear as a general indication of age-at-death. The occlusal attrition scores, following Molnar (1971), are in Table 2. In this, 1 indicates an essentially unworn tooth, and 3 (the highest score for Gough's Cave 1) indicates that the cusp pattern is partially or completely obliterated and there are small dentine patches exposed. As can be seen, all of the anterior teeth and three of the first molars exhibit wear stage 3, the third molars exhibit wear stage 1, and the remaining teeth are in between.

Of particular relevance is the amount of wear on the third molars, which is minimal. Both mandibular third molars have slightly polished enamel, and there is a small wear facet on the mesio-buccal cusp of the right one. The difference in the amount of wear between the left and right teeth is consistent with the amount of wear on the other molars, which is higher on the right side than on the left. There is slight polishing on the upper third molars and a small wear facet on the mesio-lingual cusp of the upper right third molar. The amount of wear suggests that death occurred not long after the third molars came into occlusion. The evidence from the third molars is consistent with the relatively low level of wear on the first and second molars. Application of the Miles method (Miles 1978) for ageing using attrition on the mandibular molars indicates an age at death of between 18 and 24 years, with an age at the lower end of the scale being more likely.

The Axial Skeleton

The Vertebral Column

The indications of age-at-death in the vertebral column, as preserved and as observable given the partial articulation of the remains (originally for museum display), are as follows:

C6 or 7: Posterior tubercle of spinous process unfused.
T1: Posterior tubercle unfused.
T2 or 3: Posterior tubercle unfused.
T11: Posterior tubercle appears to be unfused.
T12: Posterior tubercle unfused, annular ring of the inferior surface is not fully fused.
L1: Posterior tubercle appears to be unfused.
L2: The tubercle of the spinous process is fused but the epiphyseal line is still open along its superior margin. The epiphyseal line between the secondary center of ossification of the inferior annular ring and the centrum is also evident (but is mostly closed and was undergoing obliteration at the time of death).
L3: The tip of the spinous process is fused but the epiphyseal line is still open along its superior edge. The inferior and superior annular rings appear to be fully fused to the centrum, with the epiphyseal lines completely obliterated.
S1–S2: Between the S1 and S2, the ventral bodies are fully separate, with a maximum gap between them of 2.3mm. Laterally and dorsally they remain unfused but the bone surfaces are in contact with each other.
S2–S3: There is clear contact but no evidence of fusion between S2 and S3 bodies.
S3–S4: There is clear contact but no evidence of fusion between S3 and S4 bodies.
S4–S5: The S4 and S5 bodies are fully fused, but the line between them is readily apparent.
S5–Cx1: There is no evidence of any bridging between the S5 and Cx1 bodies.

Summary. The secondary center of ossification for the inferior annular ring of the twelfth thoracic vertebra is unfused, and the inferior annular ring of the second lumbar vertebra is fused but the epiphyseal line remains visible. The superior and inferior annular rings of the third lumbar vertebra are clearly fused, and the epiphyseal lines are obliterated. Post-mortem damage to the bones and the presence of reconstructive materials and adherent matrix make the evaluation of the developmental state of the other vertebrae difficult. The dorsal tubercles of the spinous processes of the sixth cervical, first, second, eleventh and twelfth thoracic and first lumbar vertebrae are clearly unfused, suggesting a relatively young age at death for this individual.

Secondary centers of ossification in the vertebrae appear around puberty, and with the exception of the epiphyseal rings of the centra, are usually fused by the age of 18 years (Steele & Bramblett, 1988). Maturation of the annular rings usually begins prior to age 17 and is complete by the age of 25 (Steele & Bramblett, 1988). However, a considerable amount of individual variation exists in ages of fusion of the annular rings and other secondary centers in the vertebrae (McKern & Stewart, 1957). None of the preserved vertebrae shows any signs of osteophyte development, arthritis to the articular surfaces, or Schmorl's nodes (on the centra that can be examined), consistent with the death of this individual during the third decade.

The pattern and degree of fusion of the sacral vertebral bodies is normal for a young adult, and by reference to Euroamerican males indicates an age-at-death in the mid twenties (McKern & Stewart, 1957).

The Costal Skeleton

4 Right: The surface of the head is rough and irregular, likely representing the subchondral surface of the unfused secondary center of ossification for the head.
5 Right and Left: The secondary centers of ossification for the heads are only partially fused (and portions are missing).
6 Right and Left: The heads are incompletely fused and portions of them are missing.
7 Left: The secondary center of ossification for the head of the left rib is unfused and missing.
8 Right: The head is unfused and missing.
9 Right and Left: The centers of ossification for the heads are unfused and missing.
11 Right and Left: The heads are unfused and missing.
12 Right: The head appears to be unfused.

Summary. Most of the ribs preserving the proximal end have unfused or partially fused heads. The secondary centers of ossification for the articular tubercles are, without exception, fully fused in all the ribs retaining this region. Secondary centers for the head and tubercle generally appear around puberty and fuse between the ages of 18 and 24 (McKern & Stewart, 1957), beginning in the upper and lower end ribs and progressing towards the middle. Apparently the articular tubercles followed a more accelerated schedule of fusion than the rib heads in the Gough's Cave 1 skeleton. The developmental state of Cheddar Man's ribs suggests that he died in his late teens or early in his third decade.

The Upper Limbs

No degenerative changes are evident in any of the preserved upper limb articular surfaces, and all of the age-at-death indications are associated with the fusion and obliteration of the epiphyseal lines.

The Claviculae

Both lack the sternal epiphysis but have well preserved metaphyseal surfaces, making it clear that the sternal secondary centers of ossification were unfused.

The Right Scapula

All of the observable secondary centers of ossification are fully fused, and the epiphyseal lines are obliterated. These include the subcoracoid center, the infraglenoid center, the acromial center, and the vertebral border center (at least at the root of the spine – the only place this center can be evaluated). It is possible that the vertebral border – inferior angle center of ossification was not fully fused along its entire length, and that the preserved portion of the inferior angle represents an epiphyseal surface. Reconstructive materials obscure observation of the inferior angle, making evaluation of the state of fusion of the growth center difficult.

The Humeri

There is a very slight trace of an epiphyseal line on the anterior and medial surfaces of the proximal metaphysis just below the lesser tubercle and the articular surface of the head. The line is more apparent on the right humerus than on the left. On both humeri the line is largely obliterated on the dorsal and lateral surfaces. Even though the line is visible, the head is fully fused and the lines are near obliteration. Radiographically, a faint sclerotic line can be made out between the metaphysis and proximal epiphysis on the right humerus (despite considerable trabecular radio-opacity in the area). No such line can be distinguished amongst the trabeculae on the left

side. Distally, the epiphyses and the medial epicondyle secondary centers of ossification are fully fused and the lines obliterated (both on gross and radiographic examination) on both humeri.

The Ulnae

The proximal and distal epiphyses are fully fused. The lines between the olecranon secondary centers and the proximal shafts are obliterated (radiographically as well as on gross external examination). The left ulna has a closed but still (barely) visible epiphyseal line between the head and shaft. Sclerotic epiphyseal lines can be seen between the metaphyses and distal epiphyses of both ulnae, albeit more distinctly in the left ulna. The distal epiphyseal lines are more distinct in the antero-posterior than in the medio-lateral radiographs.

The Radii

The proximal (right and left) and distal (left) epiphyses are fully fused, and the epiphyseal lines are obliterated on gross examination. Radiographically, radiotranslucent lines can be faintly discerned on the right proximal and left distal radius in antero-posterior view.

The Hand Remains

The metacarpals and phalanges all exhibit complete fusion of the epiphyses externally.

Summary

With the exception of the proximal clavicles, all of the upper limb epiphyseal lines are either entirely fused and completely obliterated, or are essentially fused but still show a slight trace (mainly radiographically) of the fusion line. These age indicators are all in agreement, given normal variation, in assigning an age-at-death between approximately 18 and 25 years, with the absence of fusion in the proximal clavicle suggesting a maximum age estimate closer to 22 or 23 years (McKern & Stewart, 1957).

The Lower Limbs

The Pelvis

The symphyseal and auricular surfaces of the Gough's Cave 1 pelvis are completely obscured by its articulated state, so that the age-related metamorphosis of these surfaces cannot be employed for age assessment. However, the ilium and the ischium show clear age indicators. On the left ischium, the tuberosity epiphysis is unfused along the external margin from the middle of the tuberosity to the medial (pubic) end of the tuberosity; internally and proximally it is fully fused. On the right tuberosity, there is only a hint of a persistent fusion line externally, but it is partially obscured by matrix. Along the iliac crests, there is also partial fusion of the epiphyseal lines. On the right side, the crest is incompletely fused from the iliac pillar to the iliac tuberosity, being completely unfused near the pillar and tuberosity and partially fused between them. On the left side, the crest is unfused (and absent) from the iliac pillar to the ventral margin of the iliac tuberosity, and then partially fused along the tuberosity. Ventrally, there is a fusion line still apparent externally (but not internally) from the anterior superior iliac spine to the region of the pillar.

The Femora

There is no trace of the epiphyseal fusion lines on the femora externally, for the head, trochanters or condyles. Radiographically, the fusion lines are completely obliterated through the trabeculae for the heads, the greater trochanters and the right distal epiphysis. However, there is a hint of a line from the middle of the condyles to the epicondyles in the antero-posterior radiograph of the left distal femur.

The Tibiae and Fibulae

The right tibia and fibula also show no trace externally of fusion lines distinct from normal capsular attachment areas around their epiphyses. Distally, both have no trace of a fusion line radiographically, but proximally both of the these bones show a slight indication of the former fusion line. In the tibia, there is a hint of a condylar fusion line in antero-posterior view, and the trabeculae of the proximal fibula exhibit radiographically a head fusion line that is largely obliterated.

The Pedal Remains

The two lateral metatarsals have no retention of their head epiphyseal fusion lines, but the proximal metatarsal 1 still retains a slight indication of the base fusion line. It is apparent only in the medio-lateral radiographic view along the dorso-plantar middle third of the base.

Summary

The leg bone and pedal epiphyseal fusion, all of which is normally complete by late in the second decade, primarily indicates that this individual was no younger than the late second decade but is unlikely to be much older given the persistence of fusion lines radiographically around the knee and in the proximal metatarsal 1. The degree of fusion of the iliac crest, stages 1/2 of McKern & Stewart (1957), places Gough's Cave 1 most likely between the ages of 17 and 19 with the possibility of being as old as 22. The partial fusion of the ischial tuberosity suggests a similar age, most likely between 17 and 21 but unlikely to be older than about 22 years.

Summary Age Assessment

In contrast to the ambiguities of sexual determination of Gough's Cave 1, the various indicators of his age-at-death are highly consistent. All of them agree in placing Gough's Cave 1 between his late second decade and middle third decade. In this, the dentition suggests an age between about 18 and 24 years, the vertebrae suggest an age in the middle of the third decade, whereas the rib and appendicular epiphyses (including the pelvis) suggest an age between the late second and the early third decade. It therefore appears that Gough's Cave 1 was unlikely to have been younger than about 18 years at death, and most likely was not older than about 23 years at death.

REFERENCES

Buikstra, J.E. & Ubelaker, D.H. 1994. Standards for data collection from human skeletal remains. *Arkansas Archaeological Survey Report,* **44**.

Holliday, T.W. & Churchill, S.E. 2003. Gough's Cave 1 (Somerset, England): an assessment of body size and shape. *Bulletin of the Natural History Museum, Geology,* **58**(supplement): 37–44.

Howells, W.W. 1973. Cranial Variation in Man. *Papers of the Peabody Museum of Archaeology and Ethnology,* **67**: 1–259.

Humphrey, L. T. & Stringer, C. 2002. The human cranial remains from Gough's Cave (Somerset, England). *Bulletin of the Natural History Museum, Geology,* **58:** 153–168.

Key, C.A., Aiello, L.C. & Molleson, T. 1994. Cranial suture closure and its implications for age estimation. *International Journal of Osteoarchaeology,* **4**: 193–207.

McKern, T.W. & Stewart, T.D. 1957. Skeletal Age Changes in Young American Males. *Quartermaster Research and Development Center Technical Report EP-45.* Natick: Quartermaster Research & Development Command.

Meindl, R.S. & Lovejoy, C.O. 1985. Ectocranial suture closure: a revised method for the determination of skeletal age based on the lateral-anterior sutures. *American Journal of Physical Anthropology*, **68**: 47–56.

Miles, A.E.W. 1978. Teeth as an indicator of age in man. In: Butler, P.M. & Joysey, K.A. (editors), *Development, Function and Evolution of Teeth*: 455–462. London.

Molnar, S. 1971. Human tooth wear, tooth function and cultural variability. *American Journal of Physical Anthropology*, **34**: 175–190.

Moorrees, C.F.A., Fanning, E.A. & Hunt, E.E. 1963. Age variation of formation for ten permanent teeth. *Journal of Dental Research*, **42**: 1490–1502.

Oakley, K.P. 1971. British Isles. *In*, Oakley, K.P., Campbell, B.G. & Molleson, T.I. (editors), *Catalogue of Fossil Hominids II: Europe*, pp.15–43. London.

Perizonius, W.R.K. 1984. Closing and non-closing sutures in 256 crania of known age and sex from Amsterdam (AD 1883–1909). *Journal of Human Evolution*, **13**: 201–216.

Phenice, T.W. 1969. A newly developed visual method of sexing the os pubis. *American Journal of Physical Anthropology*, **30**: 297–301.

Poulhés, M.J. 1947. La branche ischio-pubienne: ses caractères sexuelles. *Bulletin et Mémoires de la Société d'Anthropologie de Paris*, (9) **6**: 191–201.

Seligman, C.G. & Parsons, F.G. 1914. The Cheddar Man: A skeleton of Late Palæolithic date. *Journal of the Royal Anthropological Institute*, **44**: 241–263.

Smith, B.H. 1991. Standards of human tooth formation and dental age assessment. *In*, Kelley, M.A. & Larsen, C.S. (editors), *Advances in Dental Anthropology*, pp. 143–68. New York.

Steele, D.G. & Bramblett, C.A. 1988. *The Anatomy and Biology of the Human Skeleton*. College Station, Texas.

Stringer, C.B. 1985. The hominid remains from Gough's Cave. *Proceedings of the University of Bristol Spelaeological Society*, **17**: 145–152.

Tague, R.G. 1989. Variation in pelvic size between males and females. *American Journal of Physical Anthropology*, **80**: 59–71.

Trinkaus, E. 2003. Gough's Cave 1 (Somerset, England): a study of the pelvis and lower limbs. *Bulletin of the Natural History Museum, Geology*, **58**(supplement): 1–21.